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# Linguistic comprehension and narrative skills predict reading ability: A 9-year longitudinal study

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**Background.** Linguistic comprehension and narrative skills encapsulate a complex array of grammatical and semantic skills that underpin complex reading comprehension processes. However, most research in this area has focused on children with reading difficulties and not on typically developing children. Also the research has mostly focused on short-term effects of these skills on reading during the primary school years. Therefore, it remains unclear what specific role linguistic comprehension and narrative skills play in typically developing children's reading beyond the primary school years.

**Aims.** With this 9-year prospective longitudinal study, we sought to clarify the independent effects of linguistic comprehension and narrative skill (at 5 years of age) on children's reading ability at 10 and 14 years of age.

**Sample.** We examined the data from 716 children ( $M_{\text{Age}} = 67$  months,  $SD = 2.13$  months), which were drawn from a major population cohort study, the Avon Longitudinal Study of Parents and Children.

**Methods.** Children's language skills were assessed at 5 and word reading and reading comprehension skills at 10 years of age. The reading achievement scores at 14 years of age were based on national curriculum test results.

**Results.** Linguistic comprehension and narrative skills at 5 years of age made unique and direct contributions to reading comprehension skills and reading achievement after accounting for general cognitive ability, memory, phonological skills, and mother's education. Moreover, listening comprehension predicted reading achievement even when prior reading skills were taken into account.

**Conclusions.** Linguistic comprehension and narrative skills are related but distinct oral language skills that continue to influence children's reading development beyond the primary school years.

There is no question that broad oral language skills play a central role in children's reading and particularly text-level reading comprehension skills (Bishop & Adams, 1990; Snow, 1991; Whitehurst & Lonigan, 1998). It is also recognized that the effect of early oral language skills on reading tends to be stronger in later primary school years when children begin to read for comprehension (Storch & Whitehurst, 2002; Vellutino, Tunmer, Jaccard,

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& Chen, 2007). Therefore, it is possible that broad oral language skills may continue to influence later reading development beyond primary school years. However, there is a paucity of longitudinal research that has examined these relations beyond the primary school years in typically developing children. Most importantly, there are considerable variations in the way in which studies operationalize broad oral language skills complicating a coherent evaluation of the research evidence in this area. Research focus on linguistic comprehension and narrative skills is particularly important, as both provide a parsimonious way of assessing an array of intertwined language processing skills that underpin complex text-level reading comprehension processes (Hogan, Adlof, & Alonzo, 2014; Roth, Speece, Cooper, & De La Paz, 1996). Yet, there is surprisingly little research in this area and the long-term role of early linguistic comprehension and narrative skills in typically developing children's later reading ability remains unclear. Hence, this 9-year longitudinal study sought to address this gap by investigating the role of linguistic comprehension and narrative skills in later reading in a normative sample of children from 5 to 14 years of age.

### ***Oral language and reading comprehension***

Theories of reading development make a distinction between the precursors of word-level reading skills and those of text-level reading comprehension skills (Bishop & Adams, 1990; Whitehurst & Lonigan, 1998). Code-level skills include phoneme and print awareness and are primarily associated with word-level reading skills (Storch & Whitehurst, 2002). As for the precursors of text-level reading comprehension skills, the research evidence highlights the central role of broader oral language skills (Catts, Adlof, & Weismer, 2006; NICHD Early Child Care Research Network, 2005; Oakhill, Cain, & Bryant, 2003). It is also recognized that these are multifaceted and complex relations. Oral language skills also form a foundation for the development of code-level skills and therefore indirectly support later reading comprehension by facilitating word-level reading skills (Storch & Whitehurst, 2002). However, the operationalization of broad oral language skills varies considerably across studies, which complicates a coherent evaluation of the specific role of linguistic comprehension and narrative skills in children's reading development.

### ***Linguistic comprehension and reading comprehension***

The simple view of reading proposes linguistic comprehension and word-level decoding as two essential skills for reading comprehension and emphasizes the evolving nature of these relations (Gough & Tunmer, 1986; Hoover & Gough, 1990). The effect of linguistic comprehension on reading comprehension increases as word-level reading skills become more efficient and cease to become a bottleneck for effective reading comprehension (Curtis, 1980; Gough, Hoover, & Peterson, 1996). Clearly, linguistic comprehension and reading comprehension share common structural language skills such as vocabulary and grammar and also draw on the same high-level processing skills such as inferencing (see Cain, Oakhill, Barnes, & Bryant, 2001; Lervåg, Hulme, & Melby-Lervåg, 2017; van den Broek, 1994). Most longitudinal research evidence in this area tends to come from retrospective studies on children with poor reading comprehension, also referred to as poor comprehenders. These children can display age-appropriate word-level reading accuracy and fluency and non-verbal cognitive ability but nonetheless struggle with reading comprehension (for a

review, see Nation, 2005). For example, in Nation and colleagues' study (Nation, Cocksey, Taylor, & Bishop, 2010) children identified as poor comprehenders at 8 years of age were found to show weaknesses in their linguistic comprehension and grammatical skills at 6 and 7 years. Similar results have been reported by others; children with poor comprehension seem to show weaknesses in their linguistic comprehension skills (Catts *et al.*, 2006; Justice, Mashburn, & Petscher, 2011).

Fewer longitudinal studies examined the specific relations between linguistic comprehension and reading comprehension in typically developing children (Adlof, Catts, & Little, 2006; Babayiğit & Stainthorp, 2011, 2014; NICHD Early Child Care Research Network, 2005). Among these, possibly the most compelling evidence for a possible causal relation between linguistic comprehension and later reading comprehension came from studies on children who have not been exposed to any reading instruction (Babayiğit & Stainthorp, 2014; NICHD Early Child Care Research Network, 2005). For example, in a large-scale prospective longitudinal study on younger children at 3 years of age, a composite measure of language comprehension and narrative skills made direct contributions to reading comprehension assessed at 8–9 years of age (NICHD Early Child Care Research Network, 2005). Hayiou-Thomas, Harlaar, Dale, and Plomin (2010) have also found that a composite measure of oral language that included both linguistic comprehension and narrative skills (storyretell) at 4.5 years of age predicted children's reading achievement on national curriculum tests at 7, 9, and 10 years of age. Unfortunately, the use of composite measures of oral language precludes an evaluation of the unique contributions of linguistic comprehension and narrative skills on later reading in these studies. In fact, very few studies have examined the relative role of early linguistic comprehension and narrative skills in children's later reading comprehension (Justice *et al.*, 2011; Roth, Speece, & Cooper, 2002).

### ***Narrative skills and reading comprehension***

Oral narratives are considered to form a bridge between spoken language and formal written language (i.e., literacy; Hedberg & Westby, 1993; Roth, 2000; Roth *et al.*, 1996; Snow, 1991; Spencer & Petersen, 2018). In support of this proposition, some have reported direct relations between narrative skills at 4 years of age and emergent literacy skills at 5 years of age (Gardner-Neblett & Iruka, 2015). As with linguistic comprehension, narrative skills such as those assessed by storyretell tasks draw on multiple language abilities, which are crucially important for effective reading comprehension, for example, comprehension of story elements, sequencing, inferencing, understanding of story structure, and semantic and grammatical skills (see Perfetti, Landi, & Oakhill, 2005). There is evidence that inference making skills, assessed by a storytelling task, relate to story comprehension in preschool years (Tompkins, Guo, & Justice, 2013). In fact, narrative skills have been integral to the early theoretical models of comprehension, which emphasized the construction and integration of a coherent mental representation of text or discourse (see Kintsch, 1988; Lesgold, & Perfetti, 1978). However, the research evidence for the role of narrative skills in children's later reading ability remains highly limited and mixed.

For example, Roth *et al.* (2002) assessed 5-year-olds' story comprehension and production and found that story production (a measure of oral narrative skills) predicted reading comprehension skills assessed at the first grade (6–7 years of age) but not the second grade (7–8 years of age). In this study, story comprehension that can be considered a measure of linguistic comprehension was the most consistent

longitudinal predictor of later reading comprehension. Similar mixed findings have been reported by Adlof, Catts, and Lee (2010) who did not find any unique predictive relations between kindergarten narrative skills and later reading comprehension. In contrast, a few studies found stronger associations between children's narrative skills and reading comprehension skills (Griffin, Hemphill, Camp, & Wolf, 2004; Justice *et al.*, 2011). In Justice *et al.*'s (2011) retrospective longitudinal study, narrative skills and linguistic comprehension at 4.5 years of age predicted the poor comprehender profile at 10–11 years of age. In line with Roth *et al.*'s study, Justice *et al.* also reported a tendency of linguistic comprehension to be a stronger predictor of poor reading comprehension than narrative skills.

Further evidence came from studies on the relations between children's narrative skills and academic achievement. In one early study, Feagans and Appelbaum (1986) found narrative skills to be important for both maths achievement and reading comprehension during the early primary years. In contrast, others (O'Neill, Pearce, & Pick, 2004) found that children's oral narrative competence at 4 years of age was not related to reading comprehension at 6 years of age.

It is not clear to what extent methodological factors might have contributed to these mixed findings. Studies vary in the way in which they operationalize linguistic comprehension, narrative, and reading comprehension skills that can influence the reported findings (Cutting & Scarborough, 2006; Griffin *et al.*, 2004). Furthermore, with the exception of a few (Adlof *et al.*, 2010), most studies have focused on early reading skills, whereas the evidence suggests that the effect of broader oral language skills takes the primacy during the latter stages of primary school when children's reading comprehension is no longer constrained by word reading efficiency (Vellutino *et al.*, 2007). Finally, studies vary in terms of the range of language skills they assess and the extent to which they take into account variables relevant to reading comprehension, such as general cognitive ability and verbal memory skills further complicating a coherent evaluation of the reported findings (Storch & Whitehurst, 2002).

### **The aim of the current study**

In this prospective longitudinal study, we aimed to elucidate the long-term role of early linguistic comprehension and narrative skills in children's reading ability. Specifically, we examined to what extent linguistic comprehension and narrative skills at 5 years of age would predict children's reading at 10 and 14 years of age. Following the previous reports (Babayigit & Stainthorp, 2014; Justice *et al.*, 2011; NICHD Early Child Care Research Network, 2005), we predicted that linguistic comprehension and narrative skills at 5 years of age would make unique contributions to children's reading at 10 and 14 years of age. Likewise, following the previous reports (Justice *et al.*, 2011; Roth *et al.*, 2002) we anticipated that linguistic comprehension would be a more powerful predictor of reading comprehension than narrative skills. Hence, the present study aimed to extend prior research: (1) by examining unique contributions of linguistic comprehension and narrative skills to children's reading development beyond the primary school years, (2) by examining these relations in a large normative sample of children, and (3) by accounting for important covariates associated with oral language and reading achievement, such as general cognitive ability, memory skills, and socioeconomic factors (mother's education).

## Method

### Participants

We used the archival data from the Avon Longitudinal Study of Parents and Children (ALSPAC), which is a large cohort study. The ethical approval for the study was obtained by the ALSPAC Ethics and Law Committee and the Local Research Ethics Committees. The ALSPAC is a major prospective population-based cohort study of all children born to mothers in an area of the South West of England (UK). Between 1991 and 1992, all pregnant women who registered their pregnancy within the National Health Service in the area were invited to participate. Over 14,000 pregnant mothers were recruited to the study, and their new born children have been followed and periodically assessed at different intervals since then (for more information on the ALSPAC sample, see Boyd *et al.*, 2013; Fraser *et al.*, 2013). A 10% of randomly selected subsample (known as the Children in Focus group) attended clinics for assessment at intervals from 4 to 61 months of age. For this study, we have focused on the developmental period from 5 (focus clinics at 61 months) to 10 and 14 years of age at which broad oral language and reading skills were assessed.

As the primary interest of the study was to examine the role of early linguistic comprehension and narrative skills in later reading ability, children with complete scores on these two oral language measures and key covariates (e.g., memory) at 5 years of age (Time 1) were included in the study. The total sample size at Time 1 (1997–98) was 716 (mean age = 67 months,  $SD = 2.13$  months; range = 65–73 months). About 4 years later, at Time 2 (2001–03; mean age = 118.5 months,  $SD = 3.89$  months), 575 of these children were assessed on a standardized reading comprehension test. At Time 3, (2005–07; mean age = 169.51 months,  $SD = 4.75$  months, range = 163–176 months), national curriculum reading achievement scores of 524 of the original sample were available.

Taken together, the participation rate from Time 1 to Time 2 was 80% (total number dropped out at Time 2 = 141) and from Time 1 to Time 3 (14 years of age) was 73% (total number dropped out at Time 3 = 192). Hence, the total attrition rate was 27%. Similar rates have been reported before in other long-term longitudinal studies (Adlof *et al.*, 2010).

Table 1 summarizes the key demographic features of the sample at Time 1. Although fewer families from lower SES and minority ethnic backgrounds are represented in the ALSPAC cohort, it is nevertheless considered broadly representative of the wider population in England (Boyd *et al.*, 2013). The scores of children on the relevant developmental and language measures were also found to be similar to the national norms of the time (Roulstone, Law, Rush, Clegg, & Peters, 2011).

### Procedure

Time 1 and Time 2 assessments were conducted one-to-one by trained staff. All language tests were conducted by qualified speech and language therapists (Roulstone, Loader, Northstone, & Beveridge, 2002), and reading comprehension test was implemented by trained psychologists. The reading achievement scores at Time 3 were obtained from the National Pupil Database. The ALSPAC website contains details of all the data that are available through a fully searchable data dictionary and variable search tool, <http://www.bristol.ac.uk/alspac/researchers/our-data/>.



**Table 1.** Demographic features of the full sample at Time 1

	Number	%
Sex		
Male	400	55.9
Female	316	44.1
Ethnicity		
White	699	97.6
Non-White	15	2.1
Mother's highest attained education <sup>a</sup>		
Certificate of Secondary Education or less	76	10.6
Vocational	52	7.3
Ordinary level	255	35.6
Advanced level	212	29.6
Degree level	121	16.9

Notes.  $N = 716$ , mean age = 67 months, and  $SD = 2.13$  months.

<sup>a</sup>For further information on academic qualifications in the United Kingdom, see Brooks (1991).

## Measures

### *Linguistic comprehension*

Verbal Comprehension subscale from the Reynell Developmental Language Scale (Reynell, 1977) provided a measure of children's linguistic comprehension. The test entails asking children to carry out instructions with small toys. The instructions gradually increase in number and complexity as the child proceeds with the test; for example, pick up the biggest pink pig and show me his eyes. The Reynell Developmental Language Scale is a widely used clinical test of speech and language difficulties in the United Kingdom and has been found to show robust psychometric properties (Edwards, Garman, Hughes, Letts, & Sinka, 1999).

### *Narrative skills*

The Renfrew Language Scales Bus Story Test (Renfrew, 1997) assessed children's narrative skills. This test involves using a picture book to tell children a story about a naughty bus. Children are then required to retell the story using the same picture book. The narrative quality is assessed in terms of the information units recalled and sentence length. The Bus Story has been found to be a reliable predictor of current and persistent language impairment (Bishop & Edmundson, 1987; Renfrew, 1997).

### *Reading comprehension and word reading*

The Revised Neale Analysis of Reading Ability (Form II; Neale, 1997) was used to assess the child's word reading accuracy and reading comprehension skills. It was administered when children turned 9.5 years of age. In this test, children read aloud a series of passages and provided spoken answers to open-ended oral questions. The average Cronbach's alpha coefficient for age groups between 9 and 10 years has been reported to be .95 for reading comprehension and .87 for reading accuracy. The parallel form reliability coefficients for reading comprehension and accuracy among similar age groups ranged between .81 and .90 (Neale, 1997).

*Reading achievement*

The reading achievement scores came from mandatory national curriculum assessments taken at 13–14 years of age in the United Kingdom (<https://www.gov.uk/national-curriculum>). These tests focused on high-level reading comprehension skills such as inference making and understanding writer's motivations and perspectives. The tests involved reading a passage and then answering open-ended questions in writing. The grading was focused on the key reading comprehension skills rather than quality of written expression (<https://dera.ioe.ac.uk/15747/7/1847219985.pdf>). Data linkage with the National Pupil Database allowed us to make direct associations between children's individual data and their educational records (Boyd *et al.*, 2013).

*Background measures*

The measures of non-word repetition, digit forward span, and non-verbal IQ were included in the data analyses to assess individual differences in phonological, verbal memory, and general cognitive skills, respectively. These measures acted as covariates in this study.

*Non-word repetition*

The non-word repetition task provides an index of phonological memory (Gathercole & Baddeley, 1996) and phonological processing skills (Snowling, Chiat, & Hulme, 1991). Children were presented with non-words via an audio cassette recorder and asked to repeat each non-word. Hence, this task requires children to analyse and reproduce the phonological structure of non-words. There were 40 non-words with syllable length ranging from 2 to 5 syllables. The split-half reliability of this test was reported to be .66 (Gathercole & Baddeley, 1996) and test–retest reliability coefficient .77 among a sample of 4- and 5-year-old children (Gathercole, 1995).

*Digit forward span*

Digit forward span task assessed verbal short-term memory skills. Children were presented with a sequence of digits for immediate serial recall. The test started with 2-digit sequences. The to-be-recalled digits increased as the child progressed through the test. There were three trial lists per digit sequence. The score was the total number of correctly recalled lists (Gathercole & Pickering, 2000). A test–retest reliability coefficient of .68 was reported in a sample of 4- and 5-year-old children (Gathercole, 1995).

*Non-verbal IQ*

Five subtests from the WISC-III<sup>UK</sup> (Wechsler, Golombok, & Rust, 1992) assessed non-verbal cognitive function at 8.5 years of age. Formal guidelines were used to compute the performance IQ based on children's scores on Picture Completion, Coding, Picture Arrangement, Block Design, and Object Assembly subtests. A measure of non-verbal cognitive ability was not available at 5 years of age. Therefore, we used the scores from the subsequent assessment period at 8.5 years of age. The test manual reports numerous indices of reliability indices for subsets and composite test scores, as well as assessments of validity (Wechsler *et al.*, 1992).



## Results

### **Preliminary analyses**

The preliminary analyses revealed small and statistically nonsignificant group differences between the participating and non-participating samples in sex ratio, Time 1 measures, and non-verbal IQ (i.e., Cohen's  $d$ s were all below .3). Tables S1 and S2 provide a summary of these analyses in Supporting Information. We found that more mothers with low education levels (i.e., mothers with General Certificate of Education Ordinary level or lower level qualifications) dropped out of the study at Time 2 (Table S1). The O' levels are subject-based academic qualifications, which act as a pathway for more in-depth academic studies and qualifications, namely Advanced level (A' level) qualification in England. A' levels are often taken prior to entry to a degree programme in England (see Brooks, 1991). (Note that O' level qualifications have been replaced by General Certificate of Secondary Education since 1988). The risk of dropout rates tends to be higher in groups with low-socioeconomic position (see Munafò, Tilling, Taylor, Evans, & Davey Smith, 2017). Therefore, this is not an uncommon finding. However, when the time periods from Time 1 to Time 3 and Time 2 to Time 3 were examined the opposite results were observed. A higher proportion of mothers with high education levels dropped out at Time 3 (Table S1). This surprising finding may in part be explained by the tendency of children from more privileged backgrounds to move to fee-paying independent (private) schools after primary school to prepare for university entrance examinations (i.e., A' level qualifications) in England. These independent schools are not required to test their students on national curriculum tests. This may explain why the reading achievement scores of children from more privileged backgrounds were missing at Time 3.

### **Descriptive statistics**

Table 2 summarizes the descriptive statistics for the study measures. There were negative skews on several measures. As the transformation of the skewed scores did not have any impact on the reported results, the original raw scores were used in the data analyses (Tabachnick & Fidell, 2013).

### **Correlations between the measures**

Table 3 shows a summary of correlations between the measures. Linguistic comprehension and narrative expression were moderately related to each other suggesting these measures were assessing related but distinct oral language skills. The rest of the correlation coefficients between measures at Time 1 ranged from small to moderate size, confirming that there was no redundancy between the Time 1 predictor measures.

The longitudinal correlation coefficients between Time 1 measures and later reading ranged from small to medium size. Finally, the three reading outcome measures (viz., word reading accuracy, reading comprehension, and reading achievement) shared large variance.

### **Path analysis: Contributions of linguistic comprehension and narrative skills to later reading ability**

#### *Preliminary considerations*

Full maximum likelihood method has been used to impute missing data (Enders, 2010). The analysis of multivariate normality indices (Mardia's test) did not indicate any

**Table 2.** Summary of the descriptive statistics

Time of assessment (mean age)	N	Mean	SD	Minimum	Maximum	Skew	Kurtosis
<b>Time 1 (5.6 years)</b>							
Linguistic comprehension	716	61.55 (0.46)	2.82 (0.49)	54 (−0.90)	67 (1.40)	−5.59 (−5.35)	−1.69 (−1.64)
Narrative skills	716	38.79	11.71	12.40	67.00	−0.46	−3.59
Digit forward span	716	12.14	2.85	1.00	22.00	1.55	1.96
Non-word repetition	716	18.78	6.68	0.00	35.00	−4.02	−1.43
<b>(8.5 years)</b>							
Non-verbal IQ	577	50.58 (100.90)	11.54 (16.61)	13 (55.00)	79 (140.00)	−2.29 (−0.23)	−0.17 (2.05)
<b>Time 2 (9.9 years)</b>							
Reading comprehension	575	26.44 (102.28)	7.24 (10.88)	1 (69.00)	41 (131.00)	−4.04 (−2.85)	−1.23 (−0.67)
Reading accuracy	575	69.12 (105.89)	19.10 (12.88)	8 (69.00)	99 (131.00)	−6.15 (−3.07)	−0.97 (−0.58)
<b>Time 3 (14.1 years)</b>							
Reading achievement <sup>a</sup>	524	24.63	8.60	2.00	47.00	−1.75	−2.44

Notes. <sup>a</sup>National curriculum test of reading. When available, the corresponding standardized scores are presented in parentheses.

Table 3. Correlations between the measures

	1	2	3	4	5	6	7	8	9	10
1. Linguistic comprehension	—									
2. Narrative skills	.324**	—								
3. Digit forward span	.329**	.238**	—							
4. Non-word repetition	.210**	.299**	.385**	—						
5. Non-verbal IQ	.252**	.282**	.200**	.135**	—					
6. Mother's education	.276**	.237**	.176**	.143**	.184**	—				
7. Sex	.090*	-.081*	.040	.026	.018	-.057	—			
8. Reading comprehension	.381**	.448**	.326**	.292**	.376**	.271**	.023	—		
9. Reading accuracy	.318**	.281**	.299**	.239**	.314**	.201**	.059	.804**	—	
10. Reading achievement	.375**	.335**	.258**	.204**	.299**	.322**	.188**	.626**	.569**	—

Notes. \*  $p < .05$ ; \*\*  $p < .01$ .

significant deviations from normality. The multivariate outlier test (Mahalanobis distance) revealed one outlier ( $p < .001$ ), which did not have any substantive effect on the reported results. Therefore, original scores were used in the path analysis. The model fit was evaluated based on the following criteria: a non-significant chi-square ( $\chi^2$ ) value at 0.05, a Bentler's comparative fit index (CFI) value larger than .95, and a root mean square error of approximation (RMSEA) smaller than .05 (Browne & Cudeck, 1993). Finally, bias-corrected percentile bootstrapping (10,000 samples) with 95% confidence interval was computed to examine the reliability of the results and the statistical significance of the indirect paths (Hayes & Scharkow, 2013). The mother's educational level and sex were included in the path model as covariates.

In this study, our primary aim was to examine the direct contributions of linguistic comprehension and narrative skills to later reading comprehension and reading achievement. It was anticipated that linguistic comprehension and narrative skills at 5 years old (Time 1) would make direct contributions to reading comprehension at 10 (Time 2) and reading achievement at 14 years of age (Time 3). Two models were compared to confirm the validity of this prediction. First, the hypothesized model with direct paths from linguistic comprehension and narrative skills to all reading outcome measures was tested and was found to provide a good fit to the data,  $\chi^2 = 5.054$ ,  $df = 4$ ,  $p = .282$ ; CFI = .999, RMSEA = .019 (90% CI 0.000, 0.062). Next, we compared this model with a competing model, which predicted direct effects from linguistic comprehension and narrative skills to Time 2 reading measures but indirect effects to Time 3 reading achievement via Time 2 reading measures. Removing the two direct paths from linguistic comprehension and narrative skills to Time 3 reading achievement led to the deterioration of the model fit,  $\chi^2 = 13.326$ ,  $df = 6$ ,  $p = .038$ ; CFI = .996, RMSEA = .041 (90% CI 0.009, 0.072), the change in chi-square was statistically significant,  $\Delta\chi^2(2) = 8.272$ ,  $p = .016$ . Hence, the findings supported our hypothesized model with direct paths from Time 1 linguistic comprehension and narrative skills to Time 3 reading achievement.

#### *Direct and indirect predictors of reading*

Table 4 shows a summary of the standardized and unstandardized parameter estimates with associated confidence intervals. Figure 1 summarizes the statistically significant direct paths. As noted earlier, a measure of non-verbal IQ was not available at 5 years of age. Therefore, the non-verbal IQ measure from 8.5 years of age was used in the analyses. Hence, the tested models included direct paths from the measures at 5 years to non-verbal IQ at 8.5 years and direct paths from non-verbal IQ to all reading measures. To simplify the presentation, these paths have been omitted from Figure 1. Instead, we present the relevant path parameter estimates in Table 4.

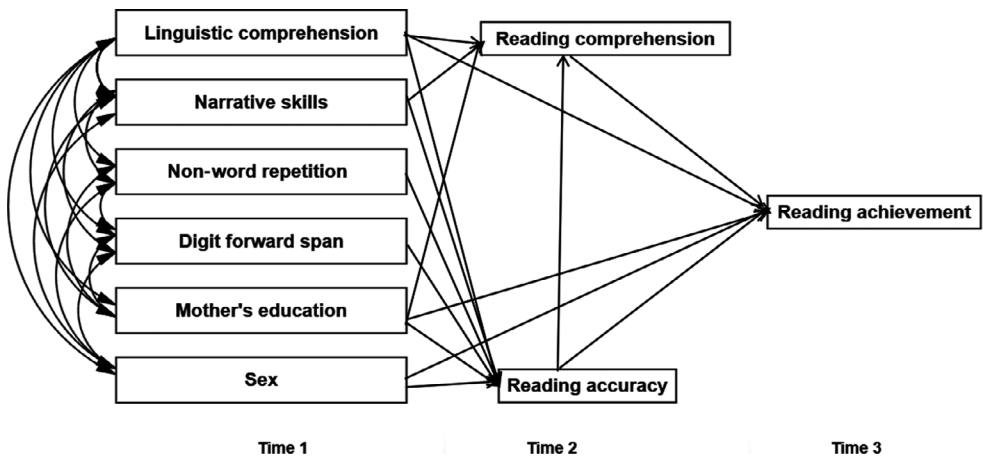
The hypothesized model explained moderate to large variance in reading outcomes ( $R^2$  was .27 for reading accuracy, .75 for reading comprehension, and .60 for reading achievement, all  $ps < .01$ ). The direct paths from linguistic comprehension and narrative skills to Time 2 reading accuracy and reading comprehension were statistically significant with small to moderate effect size. Notably, linguistic comprehension made a small but statistically significant direct contribution to Time 3 reading achievement. Finally, the indirect effects of linguistic comprehension and narrative skills to Time 3 reading achievement were all statistically significant, 0.358 [95% CI 0.238, 0.489] and 0.135 [95% CI 0.102, 0.170], all  $ps < .001$ , respectively.

**Table 4.** Direct paths: summary of parameter estimates

Direct path	Path coefficients		95% CI		<i>p</i>
	Standardized	Unstandardized	LL	UL	
Linguistic comprehension → Reading comprehension	.052	0.129	0.029	0.239	.021
Narrative skills → Reading comprehension	.199	0.118	0.092	0.143	<.001
Non-word repetition → Reading comprehension	.035	0.036	−0.005	0.079	.089
Digit forward span → Reading comprehension	.024	0.058	−0.057	0.17	.317
Mother's education → Reading comprehension	.061	0.366	0.127	0.607	.002
Sex → Reading comprehension	.004	0.061	−0.464	0.584	.826
Non-verbal IQ → Reading comprehension	.081	0.117	0.055	0.178	.002
Reading accuracy → Reading comprehension	.678	0.262	0.245	0.279	<.001
Linguistic comprehension → Reading accuracy	.144	0.915	0.47	1.363	<.001
Narrative skills → Reading accuracy	.131	0.201	0.088	0.31	.001
Non-word repetition → Reading accuracy	.086	0.230	0.022	0.443	.031
Digit forward span → Reading accuracy	.147	0.925	0.428	1.402	<.001
Mother's education → Reading accuracy	.084	1.298	0.242	2.375	.015
Sex → Reading accuracy	.067	2.421	0.301	4.643	.028
Non-verbal IQ → Reading accuracy	.224	0.834	0.52	1.138	<.001
Linguistic comprehension → Reading achievement	.083	0.235	0.081	0.395	.003
Narrative skills → Reading achievement	.030	0.020	−0.016	0.059	.268
Non-word repetition → Reading achievement	−.029	−0.035	−0.096	0.027	.257
Digit forward span → Reading achievement	.005	0.013	−0.132	0.159	.857
Mother's education → Reading achievement	.142	0.982	0.657	1.302	<.001
Sex → Reading achievement	.171	2.764	1.993	3.531	<.001
Non-verbal IQ → Reading achievement	.059	0.097	0.004	0.189	.043
Reading accuracy → Reading achievement	.209	0.093	0.056	0.129	<.001
Reading comprehension → Reading achievement	.428	0.494	0.393	0.593	<.001
Linguistic comprehension → Non-verbal IQ	.154	0.265	0.144	0.389	<.001
Narrative skills → Non-verbal IQ	.223	0.092	0.061	0.123	<.001
Non-word repetition → Non-verbal IQ	.000	0.000	−0.054	0.054	.996
Digit forward span → Non-verbal IQ	.116	0.197	0.071	0.322	.003
Mother's education → Non-verbal IQ	.102	0.423	0.118	0.738	.007

Notes. CI = confidence interval; LL = lower limit; UL = upper limit.

Not surprisingly, the proximal measures of Time 2 reading made the largest contributions to Time 3 reading achievement highlighting the stability in reading development. Following this result, an exploratory regression analysis was conducted to examine the direct relations between Time 1 measures and reading achievement at



**Figure 1.** Path model with statistically significant direct paths.

14 years of age after excluding the strong autoregressive effect of Time 2 reading skills. The results showed that both narrative skills and linguistic comprehension made unique and statistically significant contributions to reading achievement at 14 years over and above general cognitive ability, mother's education, sex, non-word repetition, and digit forward span,  $F(7, 421) = 23.99$ ,  $\beta_{\text{linguistic comprehension}} = .18$ ,  $\beta_{\text{narrative skills}} = .16$ , all  $ps \leq .001$ .

Interestingly, sex was found to make direct contributions to Time 2 reading accuracy and Time 3 reading achievement. The follow-up analyses revealed a small sex difference in favour of girls on both reading measures (Cohen's  $d = .12$  and  $.39$ , respectively). Mother's education made direct contributions to all three reading outcome measures. The follow-up ANOVAs showed that as the educational levels of mothers increased, children's reading ability increased in parallel,  $F_{\text{reading accuracy}}(4, 570) = 6.69$ ,  $p < .001$ , partial  $\eta^2 = .05$ ;  $F_{\text{reading comprehension}}(4, 570) = 12.05$ ,  $p < .001$ , partial  $\eta^2 = .08$ ;  $F_{\text{reading achievement}}(4, 519) = 15.42$ ,  $p < .001$ , partial  $\eta^2 = .11$  (for further information, see Table S3 in Supporting Information).

#### *Is linguistic comprehension a stronger predictor of reading than narrative skills?*

Finally, we examined whether there were any reliable differences in paths weights from linguistic comprehension and narrative skills to reading. For this, we constrained the paths from these two oral language measures to equality and computed the change in chi-square value. The results revealed comparable path weights for reading comprehension,  $\Delta\chi^2(1) = 0.038$ ,  $p = .845$ . However, linguistic comprehension made a larger contribution than narrative skills to Time 2 word reading accuracy,  $\Delta\chi^2(1) = 8.193$ ,  $p = .004$ , and Time 3 reading achievement,  $\Delta\chi^2(1) = 6.659$ ,  $p = .01$ .

## **Discussion**

Linguistic comprehension and oral narrative skills draw on an array of language skills, which are specifically associated with high-level reading comprehension processes in older and more skilled readers (see Kintsch, 1988; Perfetti *et al.*, 2005; Storch & Whitehurst, 2002). Therefore, a long-term developmental perspective is essential to



clarify the role of these foundational oral language skills in children's reading development. However, thus far, most studies have focused on limited developmental periods and mostly on early readers or readers with reading difficulties, which complicates the evaluation of previous mixed reports in this area. Other common methodological limitations include small sample size, differences in conceptualization and measurement of oral language skills, and lack of consideration of important covariates such as general cognitive ability. This 9-year prospective longitudinal study enabled us to address most of these limitations and extend the prior research: (1) by investigating a large sample of typically developing children over a long period of time that extends beyond the primary school years, (2) by investigating independent contributions of linguistic comprehension and narrative skills to later reading comprehension development, and (3) by considering a range of important covariates including general cognitive ability and memory skills.

Our findings not only confirmed previous reports that linguistic comprehension skills play a unique role in children's later reading comprehension development but also extended these findings to narrative skills (see Babayiğit & Stainthorp, 2014; Justice *et al.*, 2011; NICHD Early Child Care Research Network, 2005). More specifically, we found that linguistic comprehension and narrative skills at 5 years of age made unique direct contributions to reading comprehension at 10 years of age and indirect contributions to reading achievement at 14 years. Therefore, this study, for the first time, has revealed evidence that narrative skills at 5 years of age make independent contributions to children's reading comprehension at 10 years of age and reading achievement at 14 years of age over and above linguistic comprehension, general cognitive ability, verbal memory skills, and mother's education. It is notable that linguistic comprehension also made a direct, albeit small, contribution to reading achievement at 14 years even when the strong autoregressive effect of prior reading skills at 10 years was taken into account.

Next, we compared the predictive power of linguistic comprehension and narrative skills. The results provided partial support for the previous reports (i.e., Justice *et al.*, 2011; Roth *et al.*, 2002). The contributions of linguistic comprehension and narrative skills to reading comprehension at 10 years of age were comparable, but linguistic comprehension made a larger contribution than narrative skills to word reading accuracy at 10 years of age and reading achievement at 14 years of age. However, the differences in effect sizes were small, so these results should be treated as tentative.

Taken together, it was remarkable that linguistic comprehension and narrative skills made unique contributions to reading achievement assessed 9 years later and over and above general cognitive ability, mother's education, and phonological and verbal memory skills. These findings are particularly compelling, given that children's oral language skills were assessed at the very early stages of reading development and so their oral language skills were unlikely to have been substantially influenced by their reading skills.

Clearly, to understand oral language skills that underpin children's reading comprehension development, we need to go beyond the linguistic comprehension skills and the simple view of reading: A simple storyretelling test may also serve as an early indicator of later reading comprehension ability. Linguistic comprehension and narrative skills share common components such as inferencing and formation of a mental representation of the spoken language, but they also differ in several ways. In this study, the linguistic comprehension test was a test of receptive oral language comprehension skills and did not require an oral narrative output (answer) from the child. In contrast, the storyretell test required receptive oral language comprehension skills and an oral narrative output (i.e., expressive language skills). Therefore, together the task demands of oral language tests in this study closely matched those of the reading comprehension tests, which required a

narrative output. It is possible that a mismatch in task demands may explain some of the previous mixed findings. For example, the use of cloze sentences or multiple-choice questions to assess reading comprehension (Adlof *et al.*, 2010) may not capture the relations between narrative skills and reading comprehension to the same extent because cloze sentences or multiple-choice questions do not require a narrative output. Likewise, the limited language comprehension demands of reading tasks may explain the null results in some studies with young readers (O'Neill *et al.*, 2004).

The important role of mother's education in children's reading development was also evident in this study: It made direct contributions to all reading outcome measures, and as the mother's educational levels increased, their children's reading scores also increased in tandem. Mother's education is a sensitive measure of socioeconomic status, and similar findings have been reported before (Adlof *et al.*, 2010). Although genetic factors play a role in reading skills (Hayiou-Thomas *et al.*, 2010), children from low socioeconomic backgrounds tend to be particularly at risk of language delay, poor reading, and underachievement on national curriculum tests (Ginsborg, 2006; Hart & Risley, 1995; Law *et al.*, 2017; Wren, Miller, Peters, Emond, & Roulstone, 2016). Therefore, these findings were not surprising and further highlighted the long-term effect of socioeconomic factors in children's reading outcomes. Finally, in accordance with the national trends, we have also found a sex bias in favour of girls in reading achievement (Department for Education & Skills, 2007), but the effect size was small.

### **Limitations, implications, and the way forward**

This 9-year prospective longitudinal study allowed us to conduct a robust analysis of the role of early linguistic comprehension and narrative skills in children's later reading ability. There are, however, several caveats that need to be taken into account when evaluating the present findings. Multiple measures of listening comprehension, narrative skills, and reading ability were not available to compute latent variables. Therefore, our results are based on observed measures and measurement error cannot be ruled out. Likewise, code-level skills such as phoneme awareness or emergent literacy skills were not available at 5 years of age. Non-word repetition was the only measure that assessed aspects of phonological skills in this study. It is not clear to what extent this might have influenced the observed findings. Nonetheless, as the primary focus of the present study was on the specific relations between broad oral language and text-level reading comprehension skills and not the predictors of word-level reading skills, this is unlikely to be a major issue for the present study. Furthermore, any predictive variance that might be associated with phoneme awareness or emergent literacy skills is likely to be captured by the word reading accuracy scores in our hypothesized model.

It remains unclear to what extent linguistic comprehension or broad oral language skills subsume the relations between structural language skills such as vocabulary and reading comprehension or whether vocabulary plays a unique role in reading comprehension over and above the measures of broad oral language skills (see Foorman, Koon, Petscher, Mitchell, & Trukenmiller, 2015; Kim, 2017; Lervåg *et al.*, 2017). It is beyond the scope of the current study to examine this issue, which clearly warrants further investigation due to its direct implications for clinical assessment and teaching practices.

It is also worth noting that the observed effect sizes might have been different had the sample included more children from socioeconomically disadvantaged backgrounds and limits the generalization of findings to minority populations. Given the reports that the relations between oral language and reading can be even stronger for children from

socioeconomically disadvantaged backgrounds (NICHD Early Child Care Research Network, 2005), it is possible that our results underestimate the importance of broad oral language skills in reading development.

### **Conclusions and implications**

To conclude, the present study provided compelling evidence that individual differences in both linguistic comprehension and narrative skills at 5 years of age play an important long-term role in children's reading development that extends beyond the primary school years. According to estimates from 2015, about 15–20% of 4- and 5-year-old children in England show weaknesses in their communication, language, and literacy skills (Law *et al.*, 2017). As noted before, these figures are likely to be even higher in children from low-socioeconomic backgrounds (Law *et al.*, 2017). Focusing on linguistic comprehension and narrative skills may offer a robust way of capturing the complex array of semantic, syntactic, and high-level language skills that underpin text-level reading comprehension skills and has been highlighted as particularly important for promoting children's overall language development (Law *et al.*, 2017). For example, training in oral language (e.g., storytelling) has been found to improve children's storytelling skills (Davies, Shanks, & Davies, 2004), vocabulary and grammatical skills (Bowyer-Crane, *et al.*, 2008), writing (Spencer & Petersen, 2018), and early reading comprehension skills (Clarke, Snowling, Truelove, & Hulme, 2010; Fricke, Bowyer-Crane, Haley, Hulme, & Snowling, 2013). Clearly, further research is required to elucidate the long-term effects of the intervention studies in this area. Nonetheless, together our findings suggest that educational activities designed to promote children's linguistic comprehension and narrative skills may hold the key to supporting an array of intertwined receptive and expressive language skills that underpin effective reading comprehension.

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### **Conflicts of interest**

All authors declare no conflict of interest.

### **Author contributions**

Selma Babayiğit: Conceptualization, Data curation, Formal analysis, Methodology, Writing – original draft, Writing – review & editing. Sue Roulstone: Writing – review & editing. Yvonne Wren: Writing – review & editing.

## Data availability statement

The informed consent obtained from ALSPAC participants does not allow the data to be made freely available through any third party-maintained public repository. However, data used for this submission can be made available on request to the ALSPAC Executive. The ALSPAC data management plan describes in detail the policy regarding data sharing, which is through a system of managed open access. Full instructions for applying for data access can be found here: <http://www.bristol.ac.uk/alspac/researchers/access/>. The ALSPAC study website contains details of all the data that are available (<http://www.bristol.ac.uk/alspac/researchers/our-data/>).

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### **Supporting Information**

The following supporting information may be found in the online edition of the article:

**Table S1.** Participating versus nonparticipating samples across the three assessment periods: group differences in mother's education and sex

**Table S2.** Participating versus nonparticipating samples across the three assessment periods: group differences in Time 1 measures

**Table S3.** Mother's educational level and children's reading scores